THE INSTITUTE OF PHYSICS

47 BELGRAVE SQUARE, LONDON, S.W.1.

BULLETIN

No. 39 MARCH, 1953

CONTENTS

PROBLEMS CONCERNING THE EDUCATION OF PHYSICISTS 21

NOTICES TO MEMBERS - - - - - - - - 25
Physics in Industry Series ; Physics in Technical Colleges ; Molecular Structure and Spectroscopy ; Physical Society Exhibition ; Catalogue of Institute Publications ; Remission of Subscriptions of Members of long standing ; New Education Report ; Bournemouth Convention

WITHOUT COMMENT - - - - - - - - 26

PHYSICS IN TECHNICAL COLLEGES - - - - - 27
1. Manchester College of Technology. By H. Lipson

REVIEW OF BOOKS - - - - - - - - - 29
R. S. Silver, M. P. Topping and J. Topping, J. E. Roberts, I. I. Berenblut, E. D. van Rest

NEWS OF MEMBERS - - - - - - - - 31

APPOINTMENTS VACANT - - - - - - - 31

Information in this Bulletin is not intended for general publication: your copy should not therefore be passed to a library.

PROBLEMS CONCERNING THE EDUCATION OF PHYSICISTS

This Report was prepared for the Board of The Institute of Physics by its Education Committee, constituted as follows : T. L. Ibbs, M.C., D.Sc., F.Inst.P. (*Chairman*) ; N. A. de Bruyne, M.A., Ph.D., F.Inst.P. ; T. C. Keeley, C.B.E., M.A., F.Inst.P. ; Major General C. Lloyd, C.B., C.B.E., B.Sc., F.Inst.P. ; K. A. G. Mendelssohn, M.A., D.Phil., F.Inst.P., F.R.S. ; G. R. Noakes, M.A., F.Inst.P. ; H. L. Penman, B.Sc., Ph.D., F.Inst.P. ; F. Y. Poynton, M.Sc., F.Inst.P. ; W. H. Reynolds, O.B.E., B.Sc., F.Inst.P. ; E. W. H. Selwyn, B.Sc., F.Inst.P. ; W. H. Taylor, M.A., D.Sc., F.Inst.P. ; J. Thomson, M.A., D.Sc., F.Inst.P. ; J. Topping, M.Sc., Ph.D., F.Inst.P. ; W. Somerville Vernon, M.Sc., F.Inst.P. ; Professor F. A. Vick, O.B.E., Ph.D., F.Inst.P. ; G. W. Warren, M.B.E., B.Sc., F.Inst.P. ; C. G. Wynne, M.A., F.Inst.P. ; and, as *ex officio* members of the Committee, the following officers of the Institute :

C. Sykes, D.Sc., Ph.D., F.Inst.P., F.R.S. (*President*) ;
S. Whitehead, M.A., D.Sc., F.Inst.P. (*Honorary Treasurer*) ;
B. P. Dudding, M.B.E., Ph.D., F.Inst.P. (*Honorary Secretary*) ;
H. R. Lang, B.Sc., Ph.D., F.Inst.P. (*Secretary*) ;
N. Clarke, B.Sc., F.Inst.P. (*Deputy Secretary*), Secretary to the Committee.

PREAMBLE

The Institute's recently published report " The Scientific Education of Physicists " gives factual information about the various institutions in this country at which professional education in physics is available. Its publication formed part of the revision of an earlier report (1943) on the education and training of physicists in which the Institute had recommended some changes and developments in educational facilities in physics. In the changed circumstances of the present time, it is desirable to give, in this separate document, the Institute's suggestions and recommendations on questions which might involve either a change of policy on the part of official bodies (such as the universities or public examining boards), or a change of outlook on the part of individual teachers in schools and universities.

INTRODUCTION

Important developments in a number of directions can be recorded since the publication of the 1943 report by The Institute of Physics. The hope was then expressed that students with the necessary ability to profit by it should have the opportunity of taking a university course. It was suggested that a scheme on the lines of the war-time State Bursary system, which had at that time been instituted, should replace the old highly competitive University Scholarship system. This need has now largely been met by the substantial increase in the number of State Scholarships and Local Education Authority awards which are available. The recommendation that the four-year teachers' training grants should be withdrawn has been implemented with the result that the special grants previously given to intending teachers have been merged in the general system of university awards.

The school leaving age has been raised to 15, as was assumed in the 1943 report. The change in the school examination system by the establishment of the General Certificate of Education represents an attempt to overcome many of the difficulties which were then pointed out—one of the chief being the tendency towards too early specialization with a consequent narrowness of education in the later years of school life. It is perhaps too early to say whether this attempt to give the schools more freedom to plan their own courses has been entirely successful. There is still need for greater co-ordination of standards among the different school examining boards, and perhaps even more for education authorities to reach agreement as to the standard they will require for making awards.

Greatly improved facilities are now available to enable students of proved ability to obtain research training through post-graduate courses : the number of D.S.I.R. grants to universities has been increased since 1943, and facilities in industrial and Government research laboratories have been extended.

The recommendation that the Institute itself should initiate short advanced (post-graduate) courses has been honoured, and many such courses have been held in collaboration with a number of universities.

Many points which were then stressed are still deserving of emphasis, e.g. the importance of social and recreational activities in school and university life, and the importance of giving more attention to the study and use of the English language. It is interesting and reassuring to find that on the whole our general views on what is fundamental for the education of a physicist have not changed.

Physics in Schools

As the primary educational concern of the Institute is the education and training of those who will become professional physicists, the schools in which the Institute must be chiefly interested, at any rate at the present time, are the grammar schools, in which physics is taught to a standard intended to lead some boys and girls to university courses. A few secondary technical schools are also beginning to provide such courses.

University physics departments have few complaints about students who have been trained by teachers who are themselves first-class physicists, enthusiastic, thorough and up-to-date. Unfortunately, however, some universities report that the proportion of their students who have had an earlier training of this kind is less than it was some years ago. We have considered some of the problems facing the schoolmaster and the public examining boards in order to try to suggest how the needs of the universities may be met.

The first difficulty of the schools, in trying to provide an adequate training for those who will ultimately become professional physicists, is the wide variation in the future careers of all those to whom the subject must be taught. Even in the sixth form, physics must be taught to (*a*) future physicists, (*b*) future chemists, engineers and metallurgists and others who will eventually need physics to "pass" degree standard, (*c*) future biologists and medical students who will probably not study the subject beyond the Advanced level of the General Certificate of Education and (*d*) those taking physics as part of a general sixth form course for cultural purposes without thought of a scientific career. Even though these groups of students should, ideally, be taught physics with differing emphases or from different points of view, in many schools they have to be taught as a single group. A syllabus drawn up to meet such differing needs must represent a compromise of conflicting interests. Attention was drawn to this point in the introduction to the suggested syllabus published in 1944 by the Cambridge Joint Advisory Committee,[1] a valuable document which, we believe, has influenced many of the examining boards. This need for compromise, combined with the greatly increased size of the sixth forms in schools to-day, makes more important than ever the need for physics teachers of the highest quality, a need to which we refer below.

Whether the public examinations and the syllabuses for them bear any responsibility for the lack of basic knowledge of physics of some university entrants must be considered. We have studied the syllabuses and examination papers of some of the examining boards and have had the views of schoolmasters upon them.

The Advanced level syllabuses in physics vary slightly in content from one examining body to another, but there is no significant difference in content or standard. The syllabuses of the Joint Matriculation Board which is administered by the Universities of Manchester, Liverpool, Leeds, Sheffield and Birmingham, and of the Oxford and Cambridge Schools Examinations Board which serves the majority of the independent schools, have been taken as examples ; these have been chosen principally because some members of the Committee have had direct experience of their operation over a number of years.

The Joint Matriculation Board Advanced syllabus is divided into two parts. Part I contains the basic minimum which all candidates are expected to cover. Part II comprises topics which will introduce students to the wider implications of physics, to modern trends and applications. This part is designed to give an opportunity for choice in the selection of parts of the subject for further or more detailed study ; in this way it is hoped to broaden the outlook on and deepen the knowledge of physics of those whose formal study of the subject may cease on leaving school, and of those who intend to pursue the study in continued education. It is not intended that the whole of Part II should be covered, and the Joint Matriculation Board suggest that some six of the twelve sections contained in Part II should be studied. The Oxford and Cambridge Advanced syllabus covers much the same ground, but without stipulating the basic minimum.

Questions in the Scholarship paper of the Joint Matriculation Board are designed to test ability to apply fundamental principles, and require no greater factual knowledge than the Advanced papers. The way in which this syllabus is to be interpreted is set out in detail for the guidance of teachers. Certain topics of the Oxford and Cambridge syllabus are indicated as for Scholarship papers only, but these are chiefly applications of the main body of the syllabus, so that as with the Joint Matriculation Board the factual content of the Advanced and Scholarship work is effectively the same. It would be difficult to cover the whole of these syllabuses of either Board in the allotted teaching time, but even where this is not specifically stated the choice of questions offered in the papers implies that it is not expected that the whole will be covered ; the result, by a kind of tacit understanding between teachers and examiners, is that about half of the more advanced topics are usually covered in detail. This point, stated so clearly by the Joint Matriculation Board, should be borne in mind by those who might criticise examination syllabuses as covering too much ground ; it is never supposed that the teaching should cover the whole syllabus. The fact that candidates do not all cover the same parts of the syllabus will produce its own difficulties later ; this must be realised.

The Open Scholarship papers of the various groups of colleges at Oxford and Cambridge range somewhat beyond the Advanced level syllabuses in factual content, and a little beyond the Scholarship level papers in severity ; and the examinations will usually be taken during the year after the General Certificate of Education at Advanced level. While the awards are relatively few, competition for them is intense, and the standard set influences nearly every grammar school in the country.

Syllabuses such as those referred to in the foregoing paragraphs should enable the good teacher to prepare students for the further study of physics at the university. Yet much more than even the best of syllabuses is required to ensure that students receive adequate preparation for further training in physics. We believe, however, that far too many of those who reach the Advanced level at school are found at the university to be poorly equipped to begin an Honours course in physics. The most widely agreed deficiencies of university

entrants in physics are their lack of curiosity and their willingness to accept statements without proof or relation to experiment. Other criticisms of the university entrant which have been expressed to us concern a lack of training in simple experimental techniques, inadequate training in the fundamentals of measurement and lack of care in the recording and treatment of results. It is realised, of course, that completely satisfactory standards in such respects can only be acquired by long-continued practice but some early training should be given in the schools, as, indeed, it is given in schools fortunate enough to have good physics teachers, satisfactory accommodation and sufficient equipment. Much better training in experimental technique is given where pupils can carry out practical exercises individually rather than in pairs.

The foregoing remarks emphasize the great importance of the first-rate teacher. There is a serious shortage of such teachers capable of giving a thorough grounding in the basic principles of the subject while capturing the interest of their students by relating their teaching to the newer developments of physics. Until steps are taken to ensure the recruitment of teachers of high quality the schools will continue to fail to meet the requirements of the universities in the quality of entrants to honours courses in physics. The worst effects of the shortage of well-qualified and able teachers have not yet been felt. Prior to 1939 it was common for the best qualified physics graduates to become teachers ; many of them, among whom are some of the best physics teachers in the schools, are now approaching the age of retirement. Physics has become a " key " profession and there are now so many attractive careers available in this subject that it is rare to find men and women of high academic qualifications in the subject willing to teach in schools. The number of physicists entering the teaching profession is not adequate to fill the present vacanciess In the near future the shortage of good teachers is likely to be far more severe and the ultimate effect upon the number of competent professional physicists available in this country will be very serious. This is to-day a major problem concerning the education of physicists. Certain recommendations which would help to improve the situation are made in the following two paragraphs but these may not be sufficiently far-reaching. The problem has been widely admitted ; it is now urgent that effective action should be taken to raise the standard of physics teaching in schools.

One essential if more teachers of the right quality are to be attracted to the schools is to ensure that the total remuneration which the physics teacher can command shall more nearly approximate to that which a qualified physicist can earn in other types of post. Better avenues of promotion must also be provided. There is evidence that disproportionally fewer graduates in science obtain headships than graduates in arts subjects. This fact, for which we can see no valid reason, is widely known and seriously discourages some suitable graduates who might be attracted to teaching. The Institute of Physics has recognized that qualified teachers of physics in schools are an integral part of the profession of physics and its membership regulations admit them to corporate membership of the Institute. The status of teachers with professional qualifications should be similarly recognized by education authorities and headmasters. Their conditions of service should include reasonable facilities to attend scientific meetings and conferences and some opportunities for creative scientific work.

A further difficulty, not sufficiently recognized by school governors or headmasters, is the inadequacy of laboratory assistance in most schools. While it is possible for a physics teacher to prepare all his demonstrations, make simple apparatus, maintain instruments in good repair, supervise stocks and order replacements, allowance is rarely made for this in his time-table. It is, of course, uneconomic to ask him to carry out such tasks. He should be primarily concerned with the efficiency of his teaching, and skilled assistance with his other duties is essential. In a grammar school of 500 pupils the physics laboratories alone can provide work for a full-time assistant who should be a skilled technician. Authorities should be prepared to appoint such men and pay them adequately. Schools which have a tradition of excellent laboratory assistance are more able, even at the present time, to recruit and retain teachers; men and women will naturally choose to go where conditions allow them to give of their best.

To our views on the teaching of physics in schools we wish to add our strong belief that the curriculum in the sixth forms should be as broad as is possible while allowing a measure of specialization in a limited range of subjects. Boys and girls develop intellectual interests and capacities which can be satisfied only by a thorough and intense study of the subject concerned. Nevertheless, neither the satisfaction of such interests nor any examination requirements should be allowed to result in specialization in a few principal subjects to the virtual exclusion of other studies. Again, it must not be overlooked that intending physicists must have natural ability and good training in mathematics. In particular, it is essential that all intending physics specialists should continue to study English and should be able to express themselves in good English *about physics*. Special attention should be given to this by teachers of physics. Clear, concise and attractive English is essential to the physicist. The schoolmaster can do much to improve a student's facility in English : much less can be done by the university lecturer.

Physics in Universities

As was stated in our recent report,[2] the nature of the Honours course in physics differs in minor respects from one university to another. Such variation is desirable provided that a physics student is always required to study mathematics, both pure and applied, and one other experimental science during the course. Also it is important that students should acquire practical experience in laboratory technique and the use of tools.

Although the variations in undergraduate courses are of only a minor nature, the branches of physics in which research is undertaken in different universities are inevitably very different. This necessarily influences the field in which an able young graduate may be introduced to research. Adverse consequences may follow any attempt to encourage students in the final year to undertake small investigations which have something of a research character. In our view, courses involving investigations of this kind are of value when properly planned and limited but they are open to abuse ; the final honours year should not be restricted by a department's research interests. Restrictions upon the research opportunities of young graduates can be removed by making research grants easily transferable among universities and research institutions and allowing them to be held at the most suitable place where the particular type of research in which the student is really interested can be undertaken. The greatest freedom of movement between universities should be encouraged at this stage.

Students with a real aptitude for work in the higher branches of physics will benefit from a training in research. More detailed observations upon this training in the universities are given below. There are also some industrial and other establishments which can provide facilities as good as, or for some purposes better than, those of the universities and in which the young graduate may obtain the necessary introduction to the methods of research. A young man whose interests lie in the fields of research undertaken by such establishments may be best advised to enter a laboratory of this kind after taking his first degree. Nowadays, also, some of the larger technical colleges and a few of the universities provide good opportunities for post graduate training in applied physics. As we indicated in an earlier report,[2] we believe that some of the best graduates in pure science should be encouraged to undertake technological research in the universities, the major technical colleges and other establishments.

University research normally leads to the degree of M.Sc. (after one year) or Ph.D. (after two or three years). The M.Sc. degree, for which attendance at some advanced lectures should normally be a requirement, can be a useful preparation for industrial and other posts, being an indication of the possession of additional knowledge or specialised techniques. It is not necessarily a clear indication of research ability. The Ph.D. degree should, in our opinion, be a valuable hall-mark of research ability. There is room for men holding this degree in both pure and applied research but the degree is not necessarily the most suitable qualification for industry. For instance, the holder of the degree should not, necessarily, be entitled to a higher salary on entering industry than that paid to a man of equal length of experience who had entered industry immediately on graduating.

We believe that the course leading to the Ph.D. should normally be of three years duration, possibly arranged as a preliminary year, in which formal training in technique might be included, and two years of research proper. It is difficult to judge capacity for research on the evidence of performance in the undergraduate course and the examinations for the first degree. It is partly for this reason that we recommend the general institution of a preliminary year, which is already insisted upon by some universities. At the end of this year students without real research ability or inclination should discontinue the course.

In many universities permission can be obtained to spend a limited period of the course for the Ph.D. degree in a laboratory outside the university, when it is in the best interest of the candidate's work that this should be done. Some leaders of industrial research are known to favour the adoption by other universities of schemes similar to that of the University of London which permits the award of the university degree of Ph.D., to physicists on the salaried staffs of industrial research laboratories for work done wholly outside the university. The universities, however, consider that one of the difficulties of such schemes is effective university supervision of the research. The evidence available to the Committee makes it appear unlikely that the universities would consider any such extension of the "external degree" system to the Ph.D. For they believe that this degree is evidence not only of research ability, as indicated by the successful completion of a piece of research work, but also of a widening of experience which follows from the candidate's contacts with others at the university, including those working in entirely different fields. The candidate for the Ph.D. degree is sometimes also required to attend additional courses not immediately related to his particular research.

The purpose of the Ph.D. is to provide a training in research and the universities should insist upon a measure of originality and resourcefulness in those to whom the degree is awarded. The standard of originality demanded should, in our opinion, be higher than is sometimes the case at present. Care should always be exercised in the selection of research students and of the problems upon which they work. The regulations of some universities require the publication of the results of work for the Ph.D. degree whereas it might occasionally be possible to provide better training in research by work unlikely to be suitable for publication. Much of the value of the training depends upon the nature of the supervision given; this supervision should always be directed towards stimulating the student to think for himself. The internal supervisor should always be associated with the examination of the candidate, although his influence upon the decision of the external examiner should not be excessive.

An added difficulty in some universities arises from the organization of research in teams. This makes more difficult the assessment of originality, resourcefulness and initiative and, indeed, it may not be easy to provide the student with adequate opportunities of displaying these qualities. We should deplore any tendency to regard Ph.D. research students, whether working in teams or individually, merely as assistants. The regulations of the Department of Scientific and Industrial Research, on the grants of which many research students are maintained, stipulate that these grants are for training in research; they are not to be regarded as salaries available for assistants in research.

Physics in Technical Colleges

The Institute has already published a report[3] on desirable developments in the field of technological education. Its views have also been published in the form of comments on the proposals recently made by the National Advisory Council for Education in Industry and Commerce.* Little more need be said here except to stress that the distinction between the functions of the universities and the technical colleges should be more clearly and more widely recognised. In our opinion, some technical colleges have been deflected from their own important field in order to train students for external university degrees. There is however a very real difference, which is perhaps not sufficiently widely understood, between the major technical colleges and the smaller institutions. Some of the major colleges, among which are a number of the London polytechnics, are very well equipped for teaching physics and they should provide courses of university standard, although not identical in content with undergraduate courses in the universities. A start has been made; for example, since 1951 the Manchester College of Technology has offered degree courses in Applied Physics in the Faculty of Technology of the University of Manchester. Somewhat earlier, in 1949, the Royal Technical College, Glasgow, instituted a "sandwich" course extending over four years which leads to the Associateship of the College in Applied Physics. It would be a stimulus to other large, well-equipped colleges if the University of London were to establish a degree similar to the new Manchester degree, awardable after a course differing in content from the usual university physics course but being equally concerned with fundamentals. Some of the larger colleges are also contributing much to the training of industrial physicists by

* Copies of the Comments are available from the Institute.

offering advanced courses in applications of physics, and teaching the appropriate theoretical branches of the subject.

Most of the technical colleges in this country, however, are not adequately equipped for advanced work in physics and we feel that they would be more adequately fulfilling their real function by offering courses such as those for the National Certificates in Applied Physics.[4]

GENERAL EDUCATION IN SCIENCE

Our primary purpose in this report is to deal with problems of education of the professional physicist but we feel strongly that some reference should be made to the wider problems of presenting science to the non-specialist. The applications of science are to-day of such concern in the lives of all citizens that an adequate introduction to science should form part of every child's education. If this is to be done with any subsequent advantage, the presentation of elementary courses in the subject should be attractive ; although quantitative aspects must not be neglected the courses need not be formal and unimaginative. Physics so taught is an important part of a cultural and liberal education. At the universities too, physics could be presented to the non-specialist. Just as science students in some universities have welcomed the opportunity of courses on non-scientific subjects, so might the arts students appreciate and benefit from suitable lectures on scientific topics.

References

(1) Syllabuses for examination taken by Sixth Form pupils in physics and chemistry. (London : Cambridge University Press).

(2) The Scientific Education of Physicists. (1952). (London: The Institute of Physics).

(3) The Education and Training of Technologists. (1948). (London : The Institute of Physics).

(4) J. Topping. National Certificate Courses in Applied Physics. (London : The Association of Technical Institutions). 1951. Reprinted in the *Bulletin*, January 1953.

The Report was approved and adopted by the Board of The Institute of Physics on January 20, 1953.

NOTICES TO MEMBERS

Physics in Industry Series — New Volume
Modern Mass Spectrometry — By G. P. Barnard.

The main purpose of this fully illustrated monograph, which was specially commissioned by the Board of the Institute, is to collect together and critically discuss the substantial body of knowledge and technique about the mass spectrometer and its uses in most branches of pure and applied science. As the Director of the National Physical Laboratory says in his Foreword " The mere bringing together of this material may well suggest other applications . . . almost any reader should find something of interest and value to him in his own work."

The author is in charge of the mass spectrometry work at the National Physical Laboratory and is in a unique position to discuss the design and errors of these new instruments and their uses. Moreover, he has been assisted in the writing of the monograph by other specialists at the N.P.L. and by several in the Universities and in industry who are using the methods of mass spectrometry for particular purposes.

The monograph opens with an introductory chapter which includes the general theory of the instrument. This is followed by chapters on ion sources, vacuum techniques and gas flow problems cognate to mass spectrometry, on the collection and measurement of ion beams and the associated electronic devices. Some existing research and industrial instruments are next described and then five chapters (115 pages) are devoted to applications in physics, chemistry and engineering, to hydrocarbon analysis, to studies of molecular structure and chemical kinetics, to applications of isotopic tracer techniques to biochemistry and to isotopic studies in geology and nuclear chemistry.

In addition to the list of some 400 references, an appendix refers to 30 reviews of mass spectometry which have been published since 1940. Those contemplating installing one or more of these instruments will find the appendix on the mass spectrometry laboratory full of useful hints including some remarks on the staff required.

The book contains 326 pages and 153 figures. Its retail price is 50s. but members of all grades of the Institute may purchase one copy each *for their personal use* at 37s. 6d. Publication date is April 15 but orders should be sent to the Institute as soon as possible.

Physics in Technical Colleges

Technical colleges play an important part in providing scientific and technical skill for industry and in extending scientific and technological knowledge by research. Yet their work is often not sufficiently appreciated ; the support received from industry and from education authorities is commonly inadequate. The Institute has for some years continually drawn attention to the importance of technical education and has endeavoured to raise the status and improve the conditions and facilities of physicists in technical colleges. In the last few years much has been achieved but economy measures and other difficulties have delayed many badly needed building extensions in colleges. Such delays are frequently particularly unfortunate for physics departments since the demand for their courses—particularly in applied physics—has grown so rapidly since the last war.

In order to illustrate the work and the difficulties of the physics departments of technical colleges, a series of articles will be published in the *Bulletin* during the next few months. The first, by Dr. H. Lipson, Head of the Physics Department of the Manchester College of Technology, appears on page 27 of this issue. Other colleges to be described are the Royal Technical College, Glasgow ; The Polytechnic, Regent Street, London ; Birmingham College of Technology ; the Royal Technical College, Salford ; the Northampton Polytechnic, London.

Molecular Structure and Spectroscopy

A Symposium on Molecular Structure and Spectroscopy will be held at the Department of Physics and Astronomy, The Ohio State University, from June 15 to June 19, 1953. Further information, and copies of the program when it becomes available, may be obtained from Professor Robert A. Oetjen, Department of Physics and Astronomy, The Ohio State University, Columbus 10, Ohio, U.S.A.

Physical Society Exhibition

The 1953 Physical Society Exhibition will be held at the Imperial College of Science and Technology, London, on the following dates :—

Monday, April 13	...	10.30 a.m. to 8 p.m. (Fellows of the Society and Press only between 10.30 a.m. and 2 p.m.)
Tuesday, April 14	...	10 a.m. to 8 p.m.
Wednesday, April 15	...	
Thursday, April 16	...	
Friday, April 17	...	10 a.m. to 5 p.m.

A limited number of tickets are available from the Institute for members who are not members of the Society. The tickets will be distributed about the middle of March in order of date of application received. The tickets are split into four groups as follows :—

1. Whole day tickets which can be used either on Monday or Friday (short days).
2. Whole day tickets which can be used on Tuesday, Wednesday or Thursday (long days).
3. Morning tickets which can be used on any one morning, 10 a.m.—1 p.m. (Tuesday to Friday).
4. Evening tickets which can be used on any one evening, 5.30 p.m.—8 p.m. (Monday to Thursday).

The Handbook will be published early in March and can be bought either at the Exhibition or ordered from the Society. (Price 6s., by post 7s. 3d.)

Catalogue of Institute Publications

An illustrated catalogue of all the Institute's publications is in preparation and will shortly be available as a booklet of about forty pages. Copies will be circulated to all members as well as to research organizations, educational establishments and booksellers at home and abroad. Members who can suggest firms or individuals who would be interested to receive copies are invited to send names and addresses to the Secretary.

Remission of Subscriptions of Members of long standing

Members over sixty-five years of age who have been Members continuously for at least twenty years are reminded that they may, if they so wish, have their future annual subscriptions remitted. If they elect to do this, however, they are then only entitled to the Institute's publications upon the same special terms as are current for Students, which at present means the receipt of the Journal of Scientific Instruments or the British Journal of Applied Physics for one guinea a year each.

New Education Report

The Education Committee's report, *Problems Concerning the Education of Physicists*, is published in this issue. Reprints in booklet form will be available shortly and members may obtain copies free of charge on request. To non-members the charge is two shillings.

The earlier report, *The Scientific Education of Physicists*, is still available, free of charge to members and at two shillings to others.

Bournemouth Convention

Members of all grades have received the detailed program of the Bournemouth Convention and forms of application to attend. They are reminded that the last date for the return of forms is March 15.

The Convention is a domestic affair of the Institute, for the benefit and enjoyment of members and their ladies. It provides a unique opportunity for the making and renewal of contacts between physicists in widely different branches of the profession and it is therefore, particularly desirable that as many as possible of the younger members and their ladies should attend.

WITHOUT COMMENT

Technical Sales Service

The following is an extract from a letter sent by a firm of instrument manufacturers in reply to a technical enquiry. It was forwarded to the Institute by a Fellow. The spelling and punctuation are the firm's.

" Replying to your request we have pleasure in enclosing a number of pamphlets describing a few of our instruments and also price lists for same.

"As to the principles involved, these are normally, indentical for all instruments and resolve in the employment of the impedance etc exerted in the material, to a definite frequency or range of frequencies, which modulates the output of the oscillator producing the frequency employed. The modulation is then calibrated by suitable instrumantation."

From the Institute's Files

Among the Institute's correspondence are letters which the permanent officers find some difficulty in dealing with to the satisfaction of the senders. The following are extracts from examples of this kind :

" My son is anxious to go to sea and he only measures 30½ inches round the chest. He has to put on 1½ inches in the next two weeks. Can your Society help him to do this ? Will you kindly send me full particulars, fees, etc., if they can."

" I am in a position to give a geometrical exposition of the problem of constructing a square the area of which is equal to the area of a given circle. The solution of this problem is based on the same philosophical inference as that on which rests the rectification of the circumference. And if the one is correct there is absolutely no reason why the other should not be just as correct.

" I have been advised to write my ideas into a book—and I am doing this. My book in addition to an analysis of the implications of the nature of the circumference which cover practically all branches of physics, the problem of finding the area of the circle, e.g. demolition and reconstruction of the circumference. a philosophical explanation of the irrationality of the diagonal, etc., will also contain an analysis of the mathematical possibility of a plurality of the ' infinite but bounded picture of the occurrent.' . . . I want to know if the world of science agrees that my solution of the problem of rectification is correct."

Reports and pamphlets are regularly received from individuals with unorthodox interpretations of natural phenomena. They are typified by the title of one printed booklet of 94 pages, " *Is there a Universe ?—The Negative Answer.*"

PHYSICS IN TECHNICAL COLLEGES

1—Manchester Municipal College of Technology

By H. LIPSON, M.A., D.Sc., F.Inst.P.

THE HISTORY OF THE DEPARTMENT

The College of Technology is a large six-storey building in the heart of Manchester, and its Physics department occupies parts of the north side of the ground floor and first floor. This is a relatively small part of the building, as might be considered appropriate for a subject such as physics in a college of technology. The tendency, however, is for the department to expand—a reflexion, perhaps, of the increasing part that physics is now taking in technology in the country as a whole.

The history of the department shows this expansion clearly. In 1905, the College undertook the duties of a Faculty of Manchester University, and the department provided the necessary Intermediate physics teaching and specialized physics lectures for chemists, engineers and other undergraduates. Research was also undertaken, and important work was carried out under Dr. H. Lowery on the optical properties of metals, and later under Dr. W. H. Taylor on X-ray diffraction. This latter research work was continued under my direction, and has enabled a steady stream of students to take masters' and doctors' degrees of Manchester University.

In 1951, an important change took place in the status of the department ; it was empowered by the University to provide a full-time course for the degree of B.Sc.Tech. in Applied Physics and thus it no longer existed mainly to supply lectures for other departments.

THE DEGREE COURSE

The idea of this course was suggested by two considerations—the shortage of places in universities, and a criticism that the established schools of physics were tending to lay too much emphasis on subjects, such as nuclear physics, which were not of great importance in industrial research. It was thought that an honours course based essentially on classical physics could still provide a sufficient test of a student's capabilities ; it would however appeal to the practically minded student rather than to one with theoretical interests.

The College provides a suitable location for such a course, since its other departments can provide the extra specialized instruction needed. For example, Electrical Engineering provides lectures on electrotechnology—motors, dynamos, distribution systems, electronics and so forth—and Mechanical Engineering provides the elements of engineering drawing, so that students should have some acquaintance with the principles of the design of instruments, and should know how to specify to an instrument maker the details of anything they might want to have constructed.

In addition to details of this sort, however, it is necessary for students to receive some instruction at honours level, and this is possible because the department is actively engaged in research. It is perhaps fortunate that the research subject—X-ray diffraction—happens to be one of considerable industrial importance, and so the teaching cannot be accused of being too academic.

The department is not aiming to have a large honours school ; about fifteen students in each year would be the maximum number, so that they can each be known fairly intimately to the staff.

OTHER CLASSES

In addition to its university work, the department has other duties. It is responsible for a full-time three-year course in ophthalmic optics, and it provides the physics content of most of the courses for Ordinary and Higher National Certificates. It does not however provide National Certificate courses in Applied Physics ; the provisions made at the Royal Technical College at Salford seem to be adequate for the surrounding district. Courses are also provided for the Intermediate and Final examinations for the external degree of the University of London.

Fig. 1. *The first-year laboratory.*

THE LABORATORIES

The department has at present only three teaching laboratories—two large ones and one smaller one for advanced work. The provision of specialized experiments provides some problems, but the ingenuity of the teaching and laboratory staff has so far been able to overcome most difficulties encountered. The main disability is that so many different classes have to be conducted in the two larger laboratories that apparatus has to be cleared away when each class is finished ; this, however, results in a particularly well-polished appearance ! (Fig. 1).

Similar troubles arise in the lecture rooms, which are used by many departments other than physics ; they are practically never free, and so the departmental steward, Mr. F. Dawson, has a trolley upon which he can set out lecture demonstrations, which can then be wheeled in as required.

Research laboratories are even more of a problem. One is a cellar which has been fitted up as an X-ray room with three sealed-off tubes and one demountable tube. At one end of the room are three dark rooms ; these are necessary because of the number of research workers (thirteen at present) and because the work of the department is particularly dependent upon photographic facilities.

Fig. 2. The workshop, with the research room in the background.

The more creative side of the research work takes place in half a room of which the other part has been partitioned off for the department's workshop. We claim that in this half room there is a greater amount of research per square foot than in any other laboratory in the country ; we do not claim that the concentration per cubic foot is so great because the room is about sixteen feet high !

It will be seen that the total accommodation is barely adequate for a department with so many different activities, and much of our work is possible only because of the initiative and enthusiasm of the teaching and laboratory staff. An imposing extension to the College is being erected, and it is hoped that when it is completed the department will be able to expand. Such expansion is, however, several years away, since the physics department will be about the last department to benefit. In the meantime, we have to be content with a restricted space.

(*The photographs shown in Figs.* 1 *and* 2 *were kindly taken by the College Photographic Department*).

WORKSHOP FACILITIES

The workshop (Fig. 2) deserves special mention. Its size is only 12 ft. by 16 ft., but this smallness is more than compensated for by the keenness and enthusiasm of our instrument maker, Mr. W. Hughes. With the minimum equipment he has been able to carry out every demand we have made upon him ; he devises instruments from often ridiculously inadequate instructions ; and he produces a finished product which even the mechanical engineering department would find it difficult to equal.

At this stage, it may be mentioned that it is the general policy of the College to rely mainly on central workshop facilities ; the Physics department is exceptional, and has proved adequately how valuable a departmental workshop can be. Much of our research work—and certainly the most creative part of it—would have been practically impossible without it. It helps to keep laboratory apparatus in good fettle, and occasional pieces of new laboratory equipment are made in it. Its fame is spreading throughout the College, and several requests have been received from other departments for assistance in making or mending apparatus.

RESEARCH

The research work of the department is its chief claim to distinction. It is concerned with X-ray diffraction generally, but particularly with the determination of the structures of organic compounds and alloys. The general principles of the subject are well known, but advance in technique is greatly hindered by the enormous growth in the necessary computations as more difficult problems are tackled. We have therefore made a new approach to the problem, based upon some ideas put forward by Sir Lawrence Bragg in Cambridge just before the war ; this approach makes use of the analogy between the diffraction of X-rays and light.

The essential requirement is an instrument for observing Fraunhofer diffraction patterns of rather coarse objects—that is, with a fine detail of a few millimetres or so. Since angles of diffraction are measured in fractions of a minute of arc, long-focal-length lenses must be used, and they must be of excellent optical quality. But fundamentally the instrument (which will be described shortly in the Journal of Scientific Instruments) is quite simple.

This instrument provides an approach at once speedy, completely reliable, and fundamentally satisfying. With it, several fairly simple structures have been quickly solved, together with one structure that had defeated certain other departments. Some still more complicated problems are now being tackled. Copies of the instrument are now being made in several other Universities.

Most of the staff (which numbers, in addition to myself, one senior lecturer and five lecturers) take part in research, and lecturing duties are kept light enough to provide reasonable time for research activity. In addition, three members of the staff of the Chemistry department are making use of our research facilities and there are at present four research students, one of whom was last year awarded an I.C.I. Fellowship. Since this was the first I.C.I. Fellowship to be awarded in the College, the physics department feels that it is setting the pace for its larger and more wealthy sister departments.

Funds for research are quite inadequate, and we have been fortunate in being able to obtain financial support from D.S.I.R., the Royal Society, and the British Iron & Steel Research Association.

EQUIPMENT

It may be deduced from the foregoing sections that the equipment of the department—both teaching and research—is not elaborate. This has been forced upon us partly by financial considerations, but it is also partly of set policy. We do not believe in complicated equipment for teaching; fundamental principles are usually best illustrated by simple, sometimes even crude, equipment. Consequently, it is not possible, in this section of this article, to give an imposing list of departmental apparatus. In some respects, however, the department is definitely deficient; we have little apparatus suitable for honours experiments, and since the final year of the honours school comes into operation next year, we propose to devote what financial resources we have to the provision of this apparatus. Enthusiasm, initiative and the departmental workshop will fill whatever gaps will be left!

CONCLUSION

I hope that I have given the impression of a young and vigorous department which is striving—I hope successfully—to make a significant contribution to physics in this country. We hope that we are producing students, who in spite of, or perhaps because of, any deficiencies of equipment, are able to hold their own with students of the more famous physics departments, and who, in time, will take prominent places in the industrial and academic life of the country.

REVIEWS OF BOOKS

The Scientific Work of Rene Descartes. By J. P. Scott, B.A., M.Sc., Ph.D. (London: Taylor & Francis Limited). Pp. 211. Price 20s.

To attempt to give a full and connected account of the scientific work of so active a genius as Descartes was a difficult undertaking. To review adequately a book in which such an undertaking has been so well accomplished, is, if the review is to be brief, almost equally difficult. Dr. Scott writes with excellent clarity, and his care of detail in presentation is wholly admirable and successful in conveying the results and significance of Descartes' scientific work. The treatment is also pleasantly free from the unscholarly "hero-worship" which often besets similar studies—in other words, Dr. Scott has conceived it his duty not only to pay full tribute to the original creations of Descartes, but also to the impact upon him of other ideas and discoveries by lesser known men.

In his Preface, the author speaks apologetically of having adopted chronological order in his treatment. The reader feels, however, that in the way in which, without undue repetition, this treatment has been used by reference back to show both the embryo and the development of later ideas—on perhaps entirely different subjects—Dr. Scott has fully justified his choice of method. Whether it was so or not, the reader is made to feel that the sequence from optics to geometry and algebra and then to general natural philosophy was an optimum path for Descartes to take.

As a careful and factual account of Descartes' scientific work, Dr. Scott's book should fulfil all that the most exacting reader may expect of it. As an appreciation of Descartes' work and its place in the history of science, he may, however, disagree with some of the views expressed by Dr. Scott, or be disappointed with the rather small extent to which the author has, in fact, committed himself. There is, however, a basic difficulty for any modern writer who is examining the work of any pre-Newtonian natural philosopher. It is a relatively easy feat of the imagination, once one is imbued with Newtonian physics, to appreciate the state of mind of Newton's successors. But in order to appreciate properly those who went before him, we should have to try to divest our minds of every vestige of Newtonian thought. In this respect, Dr. Scott is not always successful. For example, he criticises Descartes rather severely for his failure to appreciate the work of Galileo, but it is only from a post-Newtonian point of view that one can recognize Galileo's thought as superior. Dr. Scott has taken the view that Descartes' rejection of Galileo's work was a sign of his lack of concern for experimental results, although elsewhere he has accurately emphasized that Descartes' main purpose was to build up an all-embracing system of thought. In this he was like Newton, and it is more probable that it was Galileo's ideas which he rejected rather than the experimental results. It is incidental that, to our post-Newtonian world, Descartes' general scheme of mechanics was incorrect. So far as Descartes knew, it was not incorrect, and from his point of view, and with his tremendous belief in the power of a general method, to which Dr. Scott rightly gives full mention, he must have assumed that he could, at some time, reconcile in his system whatever truth there was in the reports of Galileo.

A somewhat similar difference of opinion may arise in respect of Dr. Scott's treatment of the general relation between Descartes and modern science. According to the author, while Descartes did not scoff at experiments, and was indeed himself an able observer and experimenter, he failed to recognize their decisive importance. Dr. Scott criticises a mental attitude by which a minimum of experiments suffices for a maximum of inference. One feels rather uneasy at the possible intellectual level of a science where a maximum of experiments was conducted with a minimum of inference. One might say that people like Descartes, if they are indeed guilty of the sin described by Dr. Scott, are a necessary corrective against the pedestrian tendency towards the other extreme.

But these are matters of personal opinion. Dr. Scott has given a very faithful, a very clear, and a very detailed account of Descartes' scientific work and his book will, as Professor Turnbull says in the Foreword, deservedly enhance the reputation of the author.

R. S. Silver.

Biological Hazards of Atomic Energy. Edited by A. Haddow. (London: Oxford University Press, Geoffrey Cumberlege). Pp. x + 235. Price 35s. net.

The importance of the theme of this book and the pressing nature of the problems it discusses are obvious to everyone. It is not only that the atomic bomb is now a weapon of war, grave as that is, but that the widening range of the applications of atomic physics in industry and scientific research inevitably results in more and more people being exposed to radiations. The genetic and social effects are uncertain, but sufficient is known to raise searching questions in many people's minds.

This publication is therefore to be welcomed. It comprises over twenty papers read at the Conference arranged by the

Institute of Biology and the Atomic Scientists' Association in October, 1950. The object of the Conference was, as Sir Henry Dale writes in the Foreword, " to consider, at the high level of a purely scientific enquiry, all that is known about the actions upon living organisms of the different kinds and sources of radiant energy . . . and about the dangers to human life and health. . . ." There has resulted a volume of great interest to specialists and non-specialists alike, even though in places it is a sombre story giving rise to some foreboding.

The earlier papers discuss the effects of ionising radiations on living cells in animals and plants. Physiological experiments with plants, as with animals, now often involve the use of radioactive isotopes and if conducted over long periods the radiations may give rise to serious problems. The contributions from several leading geneticists summarise our fragmentary knowledge of the effects of radiations on chromosome structure and mutation-rate. The long term effects on human populations are hinted at. Another paper gives interesting information on the incidence of cancer and on the induction of tumours by penetrating radiations. The final group of specialist contributions turns to the problems involved in the medical use of radioactive isotopes.

With all the attendant dangers there is a wide awareness of the necessity of safeguarding workers in these fields and of protecting the population generally. There are papers dealing with protective measures, the evaluation of tolerance levels, the effects of fast and slow neutrons, and the methods of control of radiation hazards at Harwell.

No reader of this Report can fail to be impressed by the range and complexity of the problems involved in the beneficent use of atomic energy ; he will also be struck by the large gaps in our knowledge and will ponder the moral and social questions that arise. These last are broached in the two final papers which discuss the scientist's responsibilities as a citizen particularly relating to the incidence of tuberculosis and lung cancer amongst workers in uranium mines, and more generally concerning the ends to which atomic energy are applied. It is right we should be reminded that " we cannot wave aside the implications of our work if we accept the responsibility of being free men."

M. P. Topping.
J. Topping.

General College Physics. By E. L. Harrington. (London : Macmillan & Co. Ltd.). Pp. vi + 787. Price 50s.

It should be made clear at once that this excellent text book is not quite what it would seem from a reading of the title. Although intended for a one year course covering all the major branches of physics, it is specifically designed for medical students. All the topics basic to the development of the subject are well covered to a standard somewhat lower than a university first year (Intermediate) course. In particular, the mathematical demands on the student are limited and calculus is avoided throughout. On the other hand, many teachers would consider that much of the material in the later part of the book, dealing with X-rays, radioactivity, nuclear physics and associated topics, though good in itself, is beyond the scope of a one year course.

The book differs considerably from other one year texts in the choice of illustrative material, which is extensive and generally of excellent quality. A large proportion of the illustrations of basic principles are taken from anatomy, physiology and even occasionally from clinical medicine. It should not be implied, however, that this is in any way a " popular " physics. Indeed, many university teachers of physics in other than medical schools would find the treatment of the subject stimulating.

Each chapter of the book ends with a substantial number of problems and a suggested list of further reading. The latter will undoubtedly arouse consternation in most students but should prove valuable to the discriminating teacher. Recent developments have made a sound, though not necessarily profound, knowledge of fundamental physical principles more necessary than ever to the doctor in training, together with a wide knowledge of the applications of these principles to biology and medicine. To the hard pressed medical school teacher of physics, faced with the problem of supplying this ever-widening need, this text book, with its fresh approach, should prove of great assistance.

J. E. Roberts

Theory of Elasticity and Plasticity. By H. M. Westergaard. (New York : John Wiley & Sons Inc.) Pp. 167. Price $5.00 ; (London : Chapman & Hall Ltd.) Price 40s.

As it is explained in an introductory note, this monograph is, unfortunately, not a complete presentation of the subjects of elasticity and plasticity, owing to the death of the author in 1950. In its present form, the book is a collection of essays on a number of aspects of the theory of elasticity, with passing references to the problems of plasticity.

The analysis of subject matter is :

History of the theories of elasticity and plasticity (37 pages) ;

Elasticity, treated by vector and tensor methods (57 pages) ;

Solutions of the equation $G\,(\nabla^2 + \frac{1}{1-2\,\mu}\nabla\mathrm{div})\,\rho + \mathbf{K} = 0$ by means of (*a*) strain potential ϕ defined by $\nabla\phi = 2\,G\rho$ (18 pages) ; and (*b*) the Galerkin vector $\mathbf{F}$ defined by $[2(1-\mu)\nabla^2 - \nabla\mathrm{div}]\mathbf{F} = 2G\rho$ (48 pages) ;

Plasticity (3 pages).

The general theory of stress and strain is developed in an elegant and terse manner. A full treatment of octahedral stress and strain is given, but torsion and flexure, which usually figure prominently in text-books on this subject, are not discussed at all. Thermal stresses find a place among the problems treated by strain potential theory. The theory of the invariants of stress and strain tensors is expounded from an intuitional standpoint, without appeal to the general transformation properties of tensors with change of axes.

Historical notes cover the period from Galileo up to the present decade. References are given to books and original papers, with especially full documentation for the period 1900–46.

The book is written to the level of a first postgraduate year in civil and mechanical engineering, and will thus form a most useful introduction to research methods. Students of mathematics and physics will be interested in the examples of practical application of the theory of Cartesian tensors. Apt and instructive exercises to be worked out by the reader, follow the text of many sections.

It should also be mentioned that the author's own considerable contributions to the subject have been incorporated in the mathematical sections.

I. I. Berenblut.

An Introduction to Statistical Calculations. By J. MOUNSEY, B.Sc. (London : English Universities Press). Pp. 351. Price 15s.

This is primarily a book of examples, mostly numerical. Its stated aim is to explain by means of worked examples the more common applications of statistical methods. The ground covered is that of the syllabuses for most commercial and some economics examinations.

The material is arranged in chapters and the scope of the book is indicated by the contents of the last. This is a very comprehensive chapter containing in addition to the tests of significance some problems involving analysis of variance, an especially effective way of explaining quality control for instance. The text consists of statements rather than explanations ; even where there are explanations the student will obviously require more. The book is intended, of course, as a supplement to lectures and will be invaluable as a source of examples both for illustration and exercise.

If there is any criticism it is that the book would be improved by a few more references back (there are some) and by the numbering of the more frequently referred to formulae. Without these references back, some of the later chapters plunge rather suddenly into their subject. A not uncommon error has been made in ascribing the need for Sheppard's corrections to unequal frequencies in the two halves of each class ; nor is the student instructed, as he should be, not to apply these " corrections " in ordinary work.

The book is to be recommended to the student preparing for the kind of examination mentioned who wishes to consolidate knowledge already acquired from text book or lecturer. And the author has certainly earned the gratitude of teachers for collecting together some 232 worked and 588 unworked examples under the ten chapter headings. The necessary statistical tables are provided as well as the answers to the unworked examples.

E. D. VAN REST.

NEWS OF MEMBERS

Fellows

G. D. ROCHESTER has been promoted from Senior Lecturer to Reader in Physics in the University of Manchester.

M. W. THRING has been appointed an Assistant Director of Research of the British Iron and Steel Research Association. He will continue as Head of the Association's Physics Department.

Associates

W. O. LOCK has been appointed a Lecturer in Physics at the University of Birmingham.

R. B. SIMS is now Research Manager of the Davy and United Engineering Company Limited, Sheffield.

Graduates

K. R. KEEP has been appointed Scientific Officer at the Ministry of Supply Establishment, Aldermaston, Berkshire.

P. W. SEDDON will shortly be taking up an appointment as Research Physicist with the Metal Box Company of South Africa Limited, Cape Town.

B. R. TAYLOR is now on the Senior Staff of the British Tabulating Machine Company Limited, Letchworth, Herts.

A. TURNER has been appointed Junior Physicist in the Research Department of Metropolitan-Vickers Electrical Company Limited, Manchester.

APPOINTMENTS VACANT

The inclusion of particulars of a vacancy must not be taken to imply that the Institute necessarily approves of the terms offered or that might be offered. Candidates should satisfy themselves that these are satisfactory, and they may always refer to the Institute for advice.

SCIENTISTS

Required by well known firm of Rubber Manufacturers, university trained **Physicist,** having first or second class honours degree. Applicants, who should be between the ages of 25 and 30, should preferably have had some industrial or research experience in the field of high polymer physics, with a bias towards engineering. Apply, General Works Manager, **British Tyre & Rubber Co. Ltd.,** Leyland, Lancs., marking the envelope " confidential."

Reed Paper Group.—Graduates (or equivalent) in chemistry, physics or chemical engineering required for senior and junior positions in Mill Chemists' Department of large modern paper mill. Work mainly concerned with plant and process control. Knowledge of paper industry an advantage. Salary according to qualifications and experience. Apply to Chief Mill Chemist, **Albert E. Reed & Co. Ltd.,** Aylesford Paper Mills, Larkfield, Nr. Maidstone, Kent.

Ilford Limited require a young **graduate in physics** to undertake work at Watford on the properties and applications of X-ray film. Previous experience of X-rays or γ-rays would be an advantage. Apply in writing to Research Director, **Ilford Limited,** Ilford, Essex.

St. Benedict's School requires for September, 1953, (1) Master to take charge of Physics Department, (2) Master to take charge of Biology Department. Standard required up to University Scholarship. S.R.A. offered. Applications to The Headmaster, Ealing, W.5.

London County Council. **Norwood Technical College. Graduate** in mathematics and physics on April 13, 1953, to teach mathematics to B.Sc. (General) standard and physics to Intermediate B.Sc. standard. Burnham Scale salary Grade B plus London allowance. Application forms obtainable from Secretary of College, Knight's Hill, S.E.27, to be returned by March 20. (178).

The Commonwealth Scientific and Industrial Research Organization invites applications for appointment to a position of **Senior Research Officer** (Theoretical Physicist), to the Division of Electrotechnology, National Standards Laboratory, Sydney, N.S.W.

Duties : the appointee would be a member of a research group which is investigating the various mechanisms of dialectric loss and the mechanism of electrical breakdown in dielectrics. In addition there is a variety of other physical investigation conducted in the laboratory which should provide additional opportunities for theoretical work.

Qualifications : university Honours degree in science and proven research ability in theoretical physics.

Salary : within the range of Senior Research Officer, £A1,304 to £A1,454 p.a., actual, £A30 increments. Salary includes a cost of living adjustment of £A180 p.a. Fare to Australia (including those of wife and family) will be paid. Appointee may be granted Superannuation privileges.

Applications, referring to appointment No. 4078, and stating full name, place and date of birth, nationality, marital state, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials and names and addresses of at least two persons willing to act as referees, should reach Mr. J. E. Cummins, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (from whom further particulars may be obtained), by April 11, 1953.

Physicist with leaning towards general physics required for interesting position—development and supervision of control tests for thermoplastics in large firm, and investigation of related production problems. Apply **B.X. Plastics Limited,** Brantham Works, Nr. Manningtree, Essex, marking envelope for the attention of Mr. L. C. Gibbons.

Physicist, Senior Grade, required for duty in the Radiotherapy Department, **Kent and Canterbury Hospital,** Canterbury. Appointment subject to Whitley conditions. Full particulars of the post and duties will be furnished on application to the Group Secretary, Central Office, Nunnery Fields Hospital, Canterbury.

The British Cotton Industry Research Association (Shirley Institute). **Physicists, research engineers** and **textile scientists** are invited to apply for the position of **Head of the Spinning Department** at the Shirley Institute. The Department, which at present has a staff of about sixty, engages in research into the processes and products of the cotton spinning industry and into the development of new machines. It deals with cotton, silk, rayon and synthetic fibres and provides technical services to the various industries that use cotton spinning machinery. The Head is required to superintend all the activities of the Department, to help with the presentation of results to the scientific world and to the industry, and to help in the formulation of research and development policy. There is an extensive program of long-term research, and it is important that the Head should be able to influence considerably the progress of this work. The Department is adequately staffed with people having knowledge of the industry and its technology and knowledge of textiles is not essential. Candidates will therefore be considered primarily for their qualities of leadership, initiative and judgment, and for their qualifications and experience as research scientists. A salary of up to £2,000 per annum will be paid, with participation in the Federated Superannuation System for Universities. Applications should be made to Dr. Toy, Director of Research, Shirley Institute, Didsbury, Manchester, 20.

Chemists and Physicists required for Atomic Energy factories at Sellafield, Cumberland ; Salwick, Preston ; and Capenhurst, Chester. Must have Honours degree, A.R.I.C., A.Inst.P., or equivalent. Salary range £406 (age 21)—£728 (age 30)—£833. Good prospects. Applications to **Ministry of Supply,** Division of Atomic Energy (Production), Risley, Warrington, quoting 420.

National Coal Board invites applications for the superannuable appointment of a **physicist** to assist in the general work of the Physics Department at the Central Research Establishment in Stoke Orchard, Nr. Cheltenham, Glos. Candidates should have had considerable experience of experimental physics and should be trained up to pass degree standard or its equivalent.

Appointment will be as Scientific Technical Officer Grade I, salary scale £730 × 25 to 880 male, and £595 × 20 to 655 × 25 to 730 female, according to qualifications and experience.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to National Coal Board, Central Research Establishment, Stoke Orchard, Nr. Cheltenham, Glos., marking envelope TT/595. Original testimonials should **not** be forwarded. Closing date March 25, 1953.

British Electricity Authority. Scientific Staff, Research Laboratories, Leatherhead. Candidates should have a First or Second Class Honours degree in Electrical or Mechanical Engineering or in Physics and preferably some research experience. Duties include testing, development and research work in the laboratories and in the field in connection with the generation, transmission and distribution of electricity. Appointments, which are superannuable, will be made within the following N.J.B. grades according to qualifications and experience :—

Second Assistant. Grade 3—£800—£1,159
Third Assistant. Grade 4—£717—£934.

Forms from D. Moffat, Director of Establishments, British Electricity House, Winsley Street, London, W.1, to be returned by March 23, 1953. Quote reference AE/337.

Assistant Manager (Pile) required at Sellafield, Cumberland, to be responsible for physical aspects of Atomic Pile operation and associated nuclear calculations. Qualifications: Honours degree in physics, A.Inst.P., equivalent. Experience in nuclear physics and handling of electronic equipment essential, managerial experience of plant operation desirable. Salary £927—£1218. Voluntary Superannuation. House within reasonable time, if married. Applications to **Ministry of Supply,** Division of Atomic Energy (Production), Risley, Warrington, quoting 427.

ASSISTANTS

Instrument mechanic with sound theoretical and practical knowledge of pneumatic and electronic recording and controlling instrument, required to take charge of installation and maintenance of instruments mainly connected with paper-making process in large modern paper mill. Salary according to qualifications and experience. Apply in writing to Chief Mill Chemist, **Albert E. Reed & Co. Ltd.,** Aylesford Paper Mills, Larkfield, Nr. Maidstone, Kent.

Industrial Radiographer required in London with practical experience in radiography, full or part-time. All applications treated confidentially. Apply Box No. A.V. 33, The Institute of Physics.

F. J. MILNER & SONS LTD PRINTERS BRENTFORD · MIDDLESEX